DOCUMENT RESUME

ED 197 958 SE 033 929

TITLE Measuring in Metric. Teacher's Manual.
INSTITUTION Hawaii Univ., Honolulu. Coll. of Education.; Hawaii Univ., Honolulu. Curriculum Research and Development Group.
SPONS AGENCY Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.; Hawaii State Dept. of Education, Hilo.
PUB DATE 79
NOTE 53p.; For related documents, see SE 033 928-930. Contains occasional light and broken type.

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Educational Games; Elementary Secondary Education; Instructional Materials; *Learning Activities; Mathematical Applications; *Mathematics Education; *Mathematics Instruction; Mathematics Materials; *Measurement; *Metric System; Problem Solving; *Teaching Guides; Tests; Worksheets

ABSTRACT

Presented is the teacher's guide to the "Measuring in Metric" supplementary mathematics textbook. The material begins with a list of 29 student objectives. The booklet and student text limit exploration to the units of measurement for length, capacity, mass, temperature, area, and volume, with only the following prefixes considered: kilo, hecto, deka, deci, centi, and milli. In addition to breaking down the student book section by section, with objectives, materials needed, helpful comments, and suggestions for other activities given, the guide includes: a metric game; a master outline of a box needed for one section of the text; a capacity and mass worksheet; a detailed list of supplies and equipment needed; three quizzes and a test; and an answer key to the student text. (MP)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED197954

U S DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

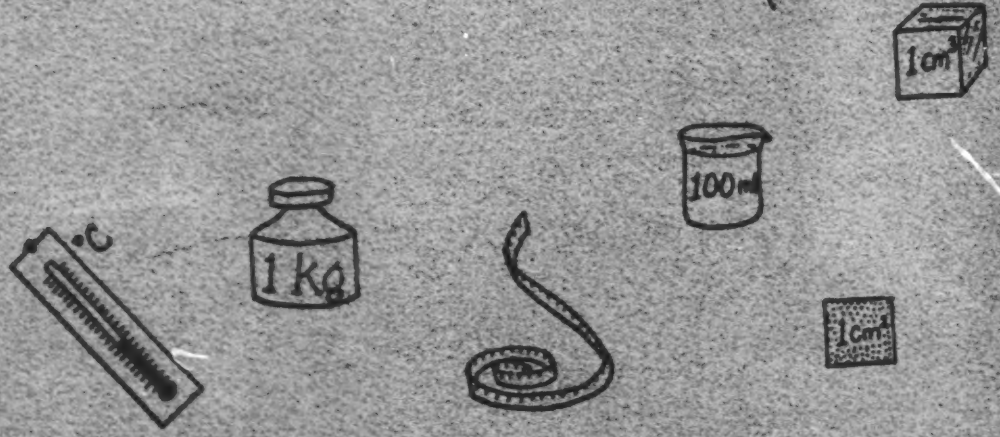
"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

P. Izumo

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

MEASURING IN METRIC

GRAMS
METERS
LITERS
KILO-
CENTI-
DECI-
MILLI-



TEACHER'S MANUAL

2

SE 033 929

ACKNOWLEDGMENTS

The Department of Education acknowledges the Curriculum Research and Development Group of the University of Hawaii, and Dr. Nancy C. Whitman, Project Administrator, for the development of this instructional module. Gratitude is extended to the teachers of Wheeler Intermediate School who participated in the pilot testing of the module. Appreciation is also extended to the district mathematics coordinators who facilitated the conduct of the pilot test.

Developed by

Curriculum Research and Development Group,
University of Hawaii
for the
Department of Education

Funded by
Title IV-C, Elementary and Secondary Act

1979

TEACHER'S MANUAL
for
Measuring in Metric

OBJECTIVES

1. Given a length or distance to be measured and a choice of three metric measurements, select the measurement which is the best approximation of that length or distance.

2. Given a length or distance to be measured and a choice of *mm*, *cm*, *m*, and *km*, select the most appropriate unit for determining that length or distance.

3. Given a meter stick, centimeter ruler or millimeter ruler, determine the length of a given object.

4. Given a specified length measure and three choices of objects or distances, select the most appropriate object or distance.
   e.g. 20 *cm* ⟶ new pencil thumbnail broom handle

5. Given a length in 0.1 centimeter, use the centimeter ruler and draw the length.

6. Recall personal height in *cm*.

7. Given a polygon or a curved figure, find the perimeter.

8. Recognize the difference between the area and perimeter.

9. Given a region and choice of cm^2, dm^2, m^2, and km^2, select the most appropriate unit for determining the area of that region.

10. Given a space and choice of cm^3, dm^3, and m^3, select the most appropriate unit for determining the volume of that space.

11. Given the name of a container and a choice of three metric measurements, select the measurement which is the best approximation of that container's capacity.

12. Given the name of a container and a choice of *ml*, *l* and *kl*, select the most appropriate unit for determining the capacity of that container.

13. Given a liter measure or a graduated cylinder calibrated in milliliters, determine the capacity of a container.

14. Given a specified capacity measurement and three choices of containers, select the most appropriate container.
   e.g. 2 *l* ⟶ soup can half-gallon milk carton oil drum

15. Given the name of an object and a choice of three metric measurements, select the measurement which is the best approximation of that object's mass.

16. Given the name of an object and a choice of *mg*, *g* and *kg*, select the most appropriate unit for determining the mass of that object.

17. Given a scale calibrated in grams or kilograms, determine the mass of a given object.

18. Given a specified measure of mass and three choices of object, select the most appropriate object.
    e.g., 3 *kg* ⟶ a car candy bar 10 lbs. of sugar

19. Recall personal weight in *kg*.

20. Given a situation involving temperature and a choice of three temperatures in degrees Celsius, select the temperature which is the best approximation of that situation

21. Given a clinical thermometer, read temperatures to the nearest tenth of a degree.

22. Recall the temperatures 100° C, 0° C, 37° C, and 20° - 30° C as the boiling point of water, the freezing point of water, the normal body temperature, and the normal temperature in Hawaii, respectively.

23. Write metric measures using accepted symbolism as determined by SI.

24. Recall the meanings of six metric prefixes: *kilo-* means thousand, *hecto-* means hundred, *deka-* means ten, *deci-* means tenth, *centi-* means hundredth, and *milli-* means thousandth.

25. Given three, four, five or six decimal numbers with at most three decimal places, find their sum.

26. Given a pair of numbers with at most three decimal places, find their difference.

27. Given a pair of numbers with at most three decimal places, find their product.

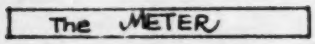
28. Recall the approximate relationships: 1 meter is a little longer than a yard, 1 liter is a little more than a quart, a little more than 2 centimeters is an inch, 5 miles is about 8 kilometers, 1 kilogram is more than 2 pounds.

29. Given a common metric measurement, convert it to another specified unit.
    e.g., 2 *m* = _____ *cm* 35 *ml* = _____ *l*

ABOUT THE METRIC SYSTEM

The International System of Units (SI) is built on seven base units and other units that are derived from these base units. This system includes a prefix for each power of ten from exo- (10^{18}) to atto- (10^{-18}). In this booklet, only the units of measurement for length, capacity, mass, temperature, area, and volume will be studied; and only the six frequently used prefixes (kilo-, hecto-, deka-, deci-, centi-, milli-) will be considered.

LENGTH



The base SI unit for length is the meter. (Sometimes spelled metre, but the -er spelling is recommended for non-technical work). Other commonly used units of length are centimeter, millimeter and kilometer.

CAPACITY

The liter (also spelled litre) is another name for a standard unit of volume, the cubic decimeter. Most commonly used capacity units are liter, milliliter, and kiloliter.

MASS

The base SI unit for mass is the kilogram. A kilogram mass is approximately equal to 2.2 pounds. Other commonly used mass units are gram and milligram. The unit of mass of very large objects is the metric ton. In this booklet, the word weight will be used to mean the same as mass.

TEMPERATURE

The Celsius scale is used to measure temperature in practical situations. The base unit, Kelvin, is used for most scientific work.

Symbols in SI are not followed by a period. A space is left between the numeral and the unit. A metric measurement less than one unit must include a zero before the decimal point. For example, 0.32 m is the notation for thirty-two hundredths meter.

Consult the following references for further information about the metric system:

Averett, D., Crump, B., & Rosenbaum, G. Think Metric, Level Green. New York: William H. Sadlier Inc., 1976.

Bright, G., & Thacker, M. Activities to Go Metric, Booklet C. Glenview: Scott, Foresman & Co., 1975.

Kempf, A., & Richards, T. Using the Metric System. River Forest: Laidlaw Bros., 1973.

Kempf, A., & Richards, T. Exploring the Metric System. River Forest: Laidlaw Bros., 1973.

Mark, F. Exploring Metrics. New York: Globe Book Co., Inc., 1976.

May, L., & Jacobs, D. Measure Metric, Book D. New York: Harcourt Brace & Jovanovich, 1974.

Odom, J. (Ed.). Successful Experiences in Teaching Metric (NBS Special Publication 441). Washington, D.C.: U. S. Department of Commerce, National Bureau of Standards, January 1976.

Whitman, N., & Braun, F. The Metric System: A Laboratory Approach for Teachers. New York: Wiley & Sons, 1978.

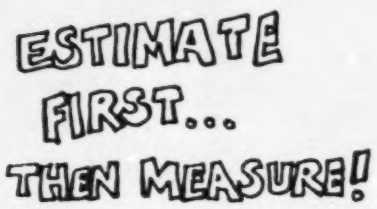
Also, the Arithmetic Teacher and the Mathematics Teacher, journals published by the National Council of Teachers of Mathematics, frequently include reviews of new metric books and materials.

Two other versions of this booklet are also available: Learning About the Metric System in High School and Measuring in Metric (for physically-handicapped students).

JAN 2 6 1981

ABOUT THE STUDENT'S BOOKLET

Measuring in Metric is written to acquaint intermediate school students with the commonly used prefixes and measurement units in the metric system through estimation and measurement activities, frame-of-reference activities, abstraction and conversion activities, and change-of-pace activities. The teacher can extend and adapt these activities to fit special situations that may arise in the classroom.



In the estimation and measurement activities, students are asked to estimate and measure objects using common metric units. Estimations will be refined as students develop a familiarity with the units. Measuring objects helps students build reference objects for various metric units and develops mental pictures of relative size of the metric units.

Frame-of-reference activities require the student to read a description of a situation and either select the most appropriate measurement or select the most appropriate unit for measuring the object.

Abstraction and conversion activities require the student to find equivalent measurements within the metric system, maintain computational skill with decimals, and compare (order) measurements.

Change-of-pace activities are incorporated to provide for variation in the lessons. Four-star problems ("brainbusters") that are related to a story-line on the top of the page are found throughout the booklet.

Upon completion of this booklet, the student should be able to:

1) Name the main metric units for length, capacity, mass, temperature, area, and volume.
2) Write the six common metric prefixes and their numerical values.
3) Measure using appropriate instruments.
4) Estimate measurement of common objects using metric units.
5) Express one metric unit in terms of another specified metric unit.

SUGGESTIONS FOR TEACHING MEASURING IN METRIC

To aid the teacher in teaching Measuring in Metric, an outline of objectives, materials needed, comments, and suggestions for other activities are provided on the following pages for each lesson. Also included are masters for quizzes and a test which could be used for pretesting and posttesting. Answers to student pages are provided at the end of the commentary. Teachers may want to transfer these answers to the pages of a student booklet for easier reference.

The teacher is encouraged to keep a log of the daily lessons on the space provided next to the outline. Questions, such as, "How can I teach this better the next time?", "Were materials sufficient?", "Is the activity more successful working in pairs or individually?", "Can I extend the lesson for the faster students?", etc., can be answered in the daily log.

Pages 1 to 2 Introduction

Objective: Understand the use of and need for the metric system.

Materials: None

Comments: Begin discussing the metric system by asking students how many have heard of it. Who uses the metric system? Can they give examples of the metric system being used in this country (state)? Examples might include buying gasoline by the liter and running in a ten kilometer race. What are some of the pros and cons of the metric system with which the students are familiar? Why should the metric system be studied? Have the class read pages 1 and 2 of the student book.

Other activities:

1) Have the students ask their parents what they know about the metric system. Do their parents ever see or use the metric units?

2) Have the students determine if any of the metric units are used in grocery stores, in department stores, in government offices, and so on.

3) Start a bulletin board display of examples of the metric system in use. Add examples provided by the students whenever possible.

Pages 3 to 5 Metric Rulers

Objective: Know the names of common metric rulers.

Materials: Meter sticks (about 6)
Adding machine tape (1 roll) cut off into longer than 1 meter lengths--one for each student
Scissors (enough to be shared in the classroom)
Oak tag or other hard paper (28 cm x 5 cm) --one for each student
Glue (about 6 bottles)

Comments: The beginning activity in these pages provides the students with a meter "stick," centimeter ruler and millimeter ruler for use throughout the remainder of this book.

ORGANIZE!

While some students are using the classroom meter sticks to cut off their meter strips, other students can be working on cutting and pasting their centimeter and millimeter rulers. This can be completed with a minimum of confusion, but organization and management are very important.

The exercises on pages 3-5 require the students to compare the different metric units. Rules for computing conversions should not be emphasized. Students should be encouraged to discuss any patterns they notice and to state generalizations. They might note things such as

--the number of millimeters is always larger than the number of centimeters

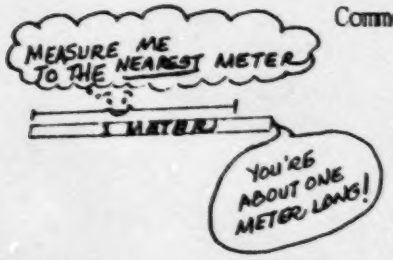
--you can't just "add a zero" to the end of the number; it doesn't always work.

--the decimal moves one place to the left (right) when changing from centimeters to millimeters (or vice-versa).

Pages 6 to 8 The Meter

Objectives: Measure to the nearest meter.
Build frame-of-reference for the meter.

Materials: Classroom demonstration meter sticks
Each student should have their own 1-meter tape.



Comments: Emphasize that the meter is the main metric unit of length. All other units are derived from it.

In exercise 2, the measurement activity asks students to measure to the nearest meter. Be sure students understand what is meant by measuring to the nearest unit. Discrepancies in students' answers should be resolved by having students with different answers explain how they arrived at their answers.

ESTIMATE

Be sure students are familiar with estimation. You might want to first estimate and then measure one of the items in exercise 2 with the entire class.

Students should recognize the usefulness of having "body meter sticks" -- armlengths

for facilitating estimates of lengths of objects; strides for estimating distances. Students should recognize that different people have different armlengths.

Exercise 9 forces students to visualize lengths of 1 meter around them.

Note: Before assigning exercises 2 and 4 find the exact measurements of each object. Students will want to know if their work is accurate.

Other activities:

1) Point to a section of the chalkboard and have students guess the length to the nearest meter.
   Record the guesses on the board.
   Select a student to measure the chalkboard section and write the measurement on the board.
   Determine the best guesser or the best row of guessers.

2) Have students interview three people during the day and ask, "How long is a meter?" Record their findings on the board to determine what percent of people interviewed generally know how long a meter is.

3) Have students measure athletic areas around the school such as a volleyball court, tennis court, etc. to the nearest meter.

Pages 9 to 11 The Centimeter

Objective: Measure to the nearest centimeter.

Materials: Centimeter ruler
String (about 60 cm long - enough to be shared in the class)
Metric height measurement chart (taped to wall)

Comments: Be sure students understand what is meant by measuring something to the nearest unit.

In exercises 4 and 5, students will need string to obtain measurements. Encourage students to use lengths of familiar objects, such as body parts, to sharpen estimation skills.

Other activities:

1) Have students work in pairs. One student draws five line segments and the partner estimates and measures their lengths. Partners then alternate their activities. Do this until each student can correctly estimate four out of five times.

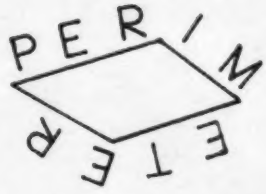
2) Have each row of students guess the length of an object. Select a different item for each row. Each row will discuss the length of their object and agree on the length. The length of their object will then be measured and the best row of guessers is chosen.

Pages 12 to 14 Perimeter

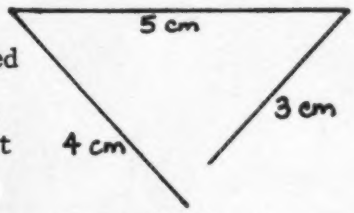
Objective: Find perimeters of polygons and curved figures.

Materials: String
Centimeter rulers

Comments: There is a tendency for students to confuse perimeter and area. The first diagram on page 12 was intended to "summarize" the idea of perimeter.



For exercise 3, students are most likely to draw first a figure that is not a polygon. Encourage them to use trial and error when drawing a closed figure (polygon). The figure shown has a length of 12 *cm* but we do not say, "Its perimeter is 12 *cm*." because perimeter means distance around.



Pages 15 to 17 The Millimeter

Objectives: Measure to the nearest millimeter.
Add and subtract measurements.

Materials: Millimeter ruler
Five nails of different lengths, labeled A, B, C, D, E
Coins - penny, nickel, dime, quarter

Comments: The need for a unit smaller than the centimeter can be suggested by measuring such objects as the thickness of eight sheets of paper or the thickness of a dime.

The nails and coins used in exercises 1 and 2 may create classroom management problems. They should be placed in different parts of the room to avoid congestion or they can be passed around. Also, if available, duplicate sets of nails would be helpful.

When measuring in millimeters, expect minor variations in answers.

Other activities:

1) For a five-minute activity, have students estimate the lengths of various objects. This activity can be done throughout the year.

2) Have students bring to class objects such as gum wrappers, candy wrappers, etc. display on the bulletin board with the measurement of the length and/or width shown.

3) For exercise 3, students may also measure the perimeter to the nearest centimeter. They should discuss why the perimeter in the example is 76 *mm* and 8 *cm* (80 *mm*) when measured to the nearest centimeter.

Pages 18 to 21 The Kilometer

Objectives: Know that 1 km is shorter than a mile
and 8 km is about 5 miles.
Recognize and extend a pattern.

Materials: None

Comments: Reading tables should be demonstrated on the overhead.

Make sure the students understand why the "X" appears in some of the regions on the table. Why aren't there numbers in these spaces?

Encourage students to do the 1 kilometer homework activity. For exercise 2, emphasize that a measurement is shown by a numeral and a unit. This is a good time to review symbols in SI.

Other activities:

1) Have students describe locations north, east, south, and west of their homes that are 1 km away. Others in the class

will guess the approximate location of that student's home.

2) Have students construct a speedometer scale for the family car in kilometers.

3) Take a kilometer walk (by counting strides).

4) Select 3 or 4 locations in your county and measure the distance by car from your school to each of these places. Examples include the Aloha Tower, Waimea Canyon, Hilo International Airport, and Haleakala. Have a contest to estimate the number of kilometers to these locations.

5) Have students ask their parents or their bus driver the number of miles from their home to school. They should then multiply this number by 1.6 to find the number of kilometers. This provides the students with another familiar frame-of-reference.

Pages 22 to 25 Length

Objectives: Use the units of length and their symbols.
Recall the meanings of the six metric prefixes.
Select the best measurement.
Select the most appropriate unit.

Materials: Meter, centimeter and millimeter rulers

Comments: This lesson reviews the commonly used metric units of length. Students should develop familiarity with the metric prefixes and their meanings.

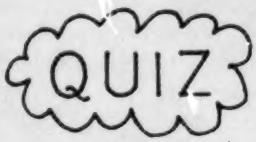
Other activities:

1) Students work in pairs. Each pair decides on the length or distance of 4 objects that everyone knows using each of the four common units (m, cm, mm, km).
For example:

Length of olympic-sized pool	50 m
Diameter of an apple	7 cm
Length of a bobby pin	50 mm
Distance from Ala Moana to Downtown	3 km

Students then present their examples to the rest of the class and the class chooses the two best examples for each of the units.

2) Divide the class into four groups. One group is assigned to draw (or cut out) pictures of 3 objects known to everyone. Each picture must be labeled "shorter than 1 meter," "longer than 1 meter," or "about 1 meter." The second group does the same with cm . The third group does the same with mm and the fourth group with km . Display the pictures with their labels on the bulletin board.



Quiz 1 can be given at this time.

Pages 26 to 32 Area

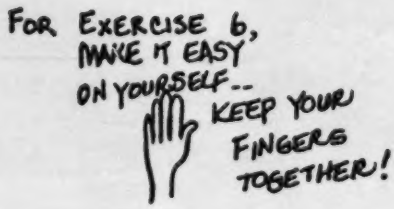
Objectives: Determine area in dm^2 by covering a region with squares.
Determine area in cm^2 by counting squares.
Select cm^2, m^2, or km^2 as the appropriate unit for measuring area.
Recognize the difference between area and perimeter.

Materials: Construction paper or index card (5" x 8")
Centimeter rulers
Scissors

Comments: Work with the square decimeter is intended to give students the experience of "covering" an unmarked region with squares. (Later, work with square centimeters show regions already marked off into squares.)

In exercise 2, be sure students understand the term polygon.

Counting parts of squares and putting them together to make whole squares should be emphasized. In exercise 3, an approximation for the area can be obtained by adding the number of full squares with one-half the number of partial squares. Exercise 6 will be a challenge for many students. Keeping the fingers together in outlining the hand will make finding the approximate area easier.



To lessen confusion that often occurs between area and perimeter, exercise 7 requires students to find both area and perimeter. Emphasize difference in units (square cm vs. cm).

Be sure students understand the definitions of square and midpoint for exercise 9.

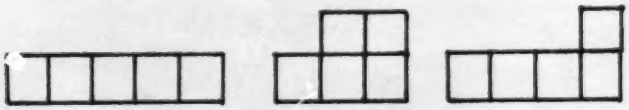
Other activities:

1) Have students use grid paper and draw rectangles 2 x 3, 1 x 4, 5 x 7, etc. and discover the formula for finding area of a rectangle using base (b) and height (h). A = b x h
Do the same for finding the area of a triangle.
Better students may be challenged to discover a formula for finding area of a trapezoid.

2) Using the geoboard, discover the formula for finding area of a polygon. One-half the number of pegs on the polygon plus the number of pegs inside the polygon minus one equals the area.

$$\frac{E}{2} + i - 1 = \text{Area}$$

3) If students need more practice in differentiating area and perimeter, they may be given a number of square decimeter regions. They arrange them in various shapes and record area and perimeter. The figures on the next page show three examples with five square decimeters.



A = 5 dm^2 P = 12 dm | A = 5 dm^2 P = 10 dm | A = 5 dm^2 P = 12 dm

4) As a variation, students may be asked to arrange four squares so the perimeter is 8 dm and then arrange them so the perimeter is 10 dm .

Pages 33 to 39 Volume

Objectives: Recognize volumes of 1 cm^3, 1 dm^3, 1 m^3.
Multiply three given dimensions to find volume.
Select cm^3 or m^3 as the best unit for finding volume.

Materials: Index cards, at least 3 cm x 4 cm
Large construction paper, at least 30 cm x 40 cm
Scissors
Centimeter rulers
Scotch tape
12 meter sticks
Masking tape

Centimeter cubes (40 per student)
Box A, 4 cm x 5 cm x 2 cm (1 per student)
(See page T-24 for master of box for duplicating)

WHY CUBES?

Comments: Spend a few minutes talking about the idea of volume. Discuss the agreement of using cubes to find volume. (See Other activities: #1.)

Have each student make the cubic centimeter and cubic decimeter and have a model of the cubic meter in the classroom. It allows the students to familiarize themselves with these units.

It is very important for the development of finding volume that each student carefully does exercises 1 and 2. Expect that some cubes may fall off of the students' desks.

Other activities:

1) A good introductory attention-getter is to have a contest to guess the number of jelly beans or M&M's, etc. in a plastic or glass container (preferably a box). Discuss the definition of volume and the disadvantages of using jelly beans, M&M's, rice, etc. as units -- leave gaps, are not uniform, etc. Then, discuss the agreement of using cubes to find volume.
For motivation: If candy is used, closest guesser can win the candy.

2) Give each student 24 centimeter cubes. Have them make boxes using all 24 cubes and record the dimensions of each box that is made.

3) Have students make a list of different boxes (by dimensions) having a common volume - such as 144 cm^3. Some would be:

12 cm	x	12 cm	x	1 cm
3 cm	x	6 cm	x	8 cm
36 cm	x	2 cm	x	2 cm

4) Challenge students with a problem such as, "It is easy to find the number of cubic centimeters in a box. Invent a way to find the number of cubic centimeters in a cup or a glass." (If they try to fill the cup with cubic centimeters they find some space not filled.)

5) Have the students imagine a supply of cubic decimeters. You want to fill the classroom with these cubic decimeters.

Have the students write a plan to determine how many of these cubes would be needed.

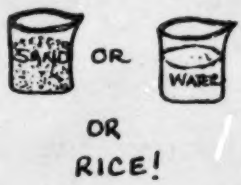
6) Have the students bring different-sized paper bags to class. They can then estimate the volume of each fully-opened bag in cubic centimeters. Ask them to describe a way to find the volume of these bags by measuring.

Pages 40 to 43 Capacity

Objectives: Measure capacity of a container to the nearest unit.
Select the best approximation of a container's capacity.
Select the most appropriate unit to determine capacity of a container.

Materials: Liter measure
Graduated cylinder marked in milliliters
Water
Soda cup, juice can, milk carton, small wastepaper basket, coffee cup, soda can, mayonnaise jar

Comments: For the measurement activities, sand or rice can be used in place of water. Teachers should be checking to see that good measurement techniques are used. While a few students are working at the measurement stations, other students should be working on other parts of this lesson.



Students who have difficulty with exercise 6 should be referred back to page 22 for help with the metric prefixes.

Other activities:

1) Have students bring to class newspaper ads where liter or milliliter is stated. Use the ads for the bulletin board display.

2) Have students look for containers whose capacity is given in metric units. Have them bring the containers to class for display in the metric corner of the classroom.

3) Label five jars -- A, B, C, D, E. Put a different amount of water in each of the jars. Have students order the capacities of water from greatest to least. Students can check their answers by measuring the capacity of each jar.

4) Students may collect containers of different shapes but of the same capacity. This may help them realize how consumers can be influenced to select a container which holds less than another container which appears smaller in size.

Pages 44 to 45 Mass

Objectives: Use the gram and kilogram scale to measure mass.
Select the most appropriate unit for determining the mass of an object.
Select the best approximation of the weight of an object.
Add and subtract decimal numbers.

Materials: Gram scale
Kilogram scale
Items to be measured: bottle, ballpoint pen, nickel, chalkboard eraser, textbooks, other objects

Comments: To keep classroom control, send students by groups of three or four to the measuring station. Other students should be working on other parts of the lesson. For exercise 5, encourage students to select personal objects such as textbooks, handbag, wristwatch, comb, pen, etc. to measure.

Other activities:

1) Have students bring to class clippings of articles or ads that use metric mass units. Put clippings on the bulletin board. Have students bring in empty containers which give metric mass units. Display the containers in the room.

2) Have each student use the gram or kilogram scale to weigh one object that they own. The name of the object and its weight is listed on the board. Have each student construct a chart showing the mass of each object from heaviest to lightest.

Pages 46 to 49 Capacity and Mass

Objective: Use the gram, kilogram, liter, milliliter, and their symbols.

Materials: Liter pitcher
Milliliter cylinder
Gram scale
Kilogram scale

Comments: This section provides additional practice in the measurement of capacity and mass. Students should be able to discriminate between the two measures.

In exercises 1 and 2, correct spelling and symbols should be stressed. The materials listed above should be available as a reference when students are doing exercises 5, 6, and 7.

You may want to discuss the table in exercise 9 before assigning it. Also, students may need a review of rounding to the nearest gram and rounding to the nearest kilogram for exercise 10.

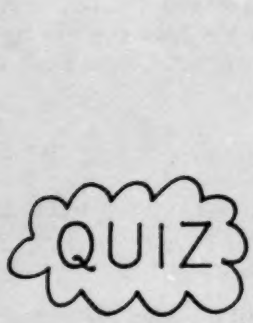
Other activities:

1) Have students write their favorite gelatin or punch recipe using metric units.

2) Have students operate a "guess your weight" booth at the school fair or as a school activity for Metric Week.

3) As a special project students may discover the relationship between the volume of water in cubic centimeters in a container and the weight of that water in grams. They should find that the two numbers are equal. Expect some differences due to the measurement process. To find the number of cubic centimeters in a container students may make their own measuring instrument. They mark heights on a plastic container to show 100, 200, etc. cubic centimeters. They pour into this marked container to measure the unknown amount of water.

4) Take a field trip to a supermarket. The students can find items which record metric weights, metric capacity units, and so on on their labels. A worksheet for this activity is provided on page T-25.* (If a field trip is not possible, students can look at home for items in exercises 8b-e.)



Quiz 2 can be given at this time.

*Students should complete exercise 8a before the field trip.

Pages 50 to 53 Temperature

Objectives: Read temperatures on a clinical and non-clinical thermometer.
Know the temperature for the freezing point of water, boiling point of water, usual temperature in Hawaii, and normal body temperature.
Select the temperature which is the best approximation for a given situation.

Materials: Celsius thermometers
Ice cubes
Dish
Glass of tap water

Comments: The Celsius thermometers for classroom use will not show normal body temperature as 37° C. Explain that the clinical thermometer is used for this purpose. To measure the temperature of a dish of ice cubes, the teacher may need to bring ice cubes in a thermos. To save time, the thermometers may be placed in the glass of water and the dish of ice cubes before class begins. Then students can read the temperature from the thermometers.

Other activity:

1) Have students take the outside temperature reading at the same time each day for 20 days. Make a line graph to record their findings.

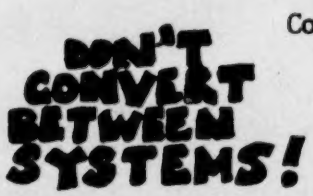
2) Have students find in the newspaper high and low temperatures for various locations in the Islands. They will find temperatures in the newspaper higher or lower than the temperatures they read at school. Why? Temperatures of various mainland and Canadian cities are also in the newspaper. Are any given in Celsius?

Pages 54 to 57 Conversions

Objective: Convert a metric measurement to another specified metric unit.

Materials: None

Comments: Linear conversions are handled first. Students are told to refer to the physical models available (their rulers) to help with establishing the pattern involved in converting metric units.

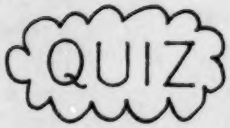


With this introduction, students are told of a shortcut. You may wish to ease this transition by providing further examples in a class discussion.

Students find it easier to convert by counting the number of places rather than by carrying out multiplication or division by powers of ten. Conversion between systems is not recommended.

Other activity:

Have students play the card game "MIND*OVER*METER", a game of concentration. Cards and a rule sheet are given at the end of this outline (page T-19).



Quiz 3 can be given at this time.

Pages 58 to 59 Metric Mania

Objective: Identify metric terms and common metric prefixes through game activities.

Materials: None

Comments: These activities provide for a change-of-pace and some review. The teacher may wish to conduct a short question-and-answer period.

Pages 60 to 61 Do You Know?

Objective: Review the highlights of Measuring in Metric.

Materials: None

Comments: These pages serve as a self-check on most of the objectives of the booklet. They can be used as a classroom review lesson or can be assigned as homework with time set aside for a short discussion on the following day prior to the posttest.

The unit test can be given at this time. You will need 5 items for the students to measure in #46-50. Some students should begin with these problems so that congestion can be avoided. Duplicate items would be helpful.

MIND*OVER*METER

The following game is a suggested "other activity" for students after completing pages 54 to 57.

"Mind*Over*Meter" is intended to reinforce students' conversion skills through a game format. Thus, before playing the game, students should have had the developmental work on converting linear metric units. The game is merely another way of providing the practice they need to "firm down" their understanding.

The game is a concentration-type card game. Masters for the cards and for a reference key are provided. The reference key is a card on which the matching combinations are listed. This may prove particularly useful for students who are still uncertain of their conversions, or for students to consult when selection of a matching pair is challenged by the other player(s).

Decks may be made in the following ways:

1. If only one or two decks are to be made, use 3" x 5" index cards, cut into halves, or 5" x 8" index cards, cut into eighths. Print with felt pens, being careful that printing is not visible on backs of cards.

2. If more than two decks are to be made, make ditto masters from the masters provided and run off on 8-1/2" x 11" vellum bristol or on 5" x 8" index cards. Then cut cards at lines indicated.

Rules for

MIND*OVER*METER

(A Game of Concentration)

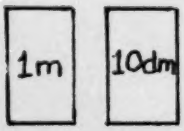
Players: 2 or 3

Materials: 1 deck of 30 Mind*Over*Meter Cards

1 Reference Key (Optional)

Object: To concentrate when the cards are turned up and to remember where each one is. Then if you find a card that matches one you have already seen, you can take the pair.

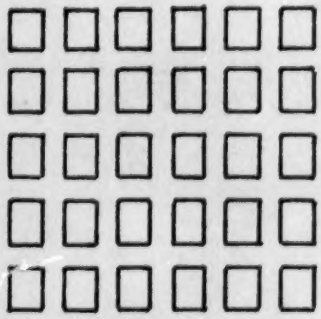
For example:



These cards match because they represent the same measurement.

Directions:

1. Shuffle the cards, being careful not to bend them.
2. Place the cards face down on the table in rows.



3. The first player turns two cards face up. If they match (measurements shown are equivalent), the player gets to keep the pair and has another turn. If they do not match, they must be turned face down again, and it is the next player's turn.
4. The players take turns turning over pairs of cards until all the cards are gone.
5. The player with the most pairs is the winner.

TO MAKE CARDS FROM 5 x 8" INDEX CARDS.
CUT DITTO HERE ✂

0.01 m	1 cm	0.2 cm	0.02 dm
2 mm	0.002 m	10 mm	0.1 dm
10 km	10,000 m	1,000 dm	1 hm
1 km	1000 m	15 mm	1.5 cm

24

25

MIND*OVER*METER CARDS T-21

USE FULL SHEET IF RUNNING ON 8½ X 11" YELLUM BRISTOL

TO MAKE CARDS FROM 5 x 8" INDEX CARDS.
✂ CUT DITTO HERE ✂

0.015 m	0.15 dm	7 mm	0.007 m
150 cm	1.5 m	1.2 km	1200 m
1 dam	10 m	0.12 m	120 mm
7 dm	70 cm		

26

27

MIND*OVER*METER CARDS T-22

USE FULL SHEET IF RUNNING ON 8½ x 11" VELLUM BRISTOL

MIND OVER METER

0.01 m 0.1 dm 1 cm 10 mm (Any two)	0.002 m 0.02 dm 0.2 cm 2 mm (Any two)	0.015 m 0.15 dm 1.5 cm 15 mm (Any two)
10,000 m 10 km	1200 m 1.2 km	1000 m 1 km
1000 dm 1 hm	10 m 1 dam	1.5 m 150 cm
7 dm 70 cm	0.12 m 120 mm	0.07 m 7 mm

T-23

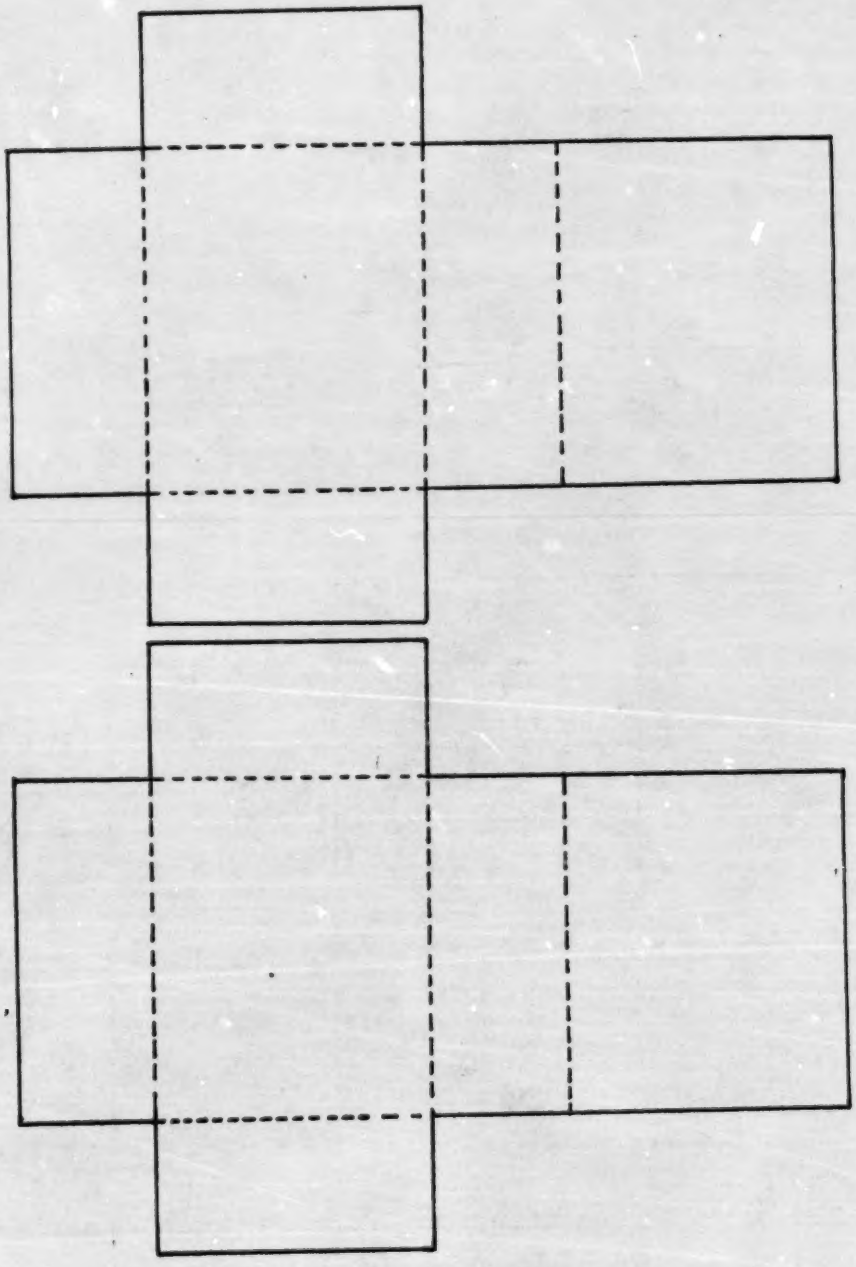
Reference Key

MIND OVER METER

0.01 m 0.1 dm 1 cm 10 mm (Any two)	0.002 m 0.02 dm 0.2 cm 2 mm (Any two)	0.015 m 0.15 dm 1.5 cm 15 mm (Any two)
10,000 m 10 km	1200 m 1.2 km	1000 m 1 km
1000 dm 1 hm	10 m 1 dam	1.5 m 150 cm
7 dm 70 cm	0.12 m 120 mm	0.07 m 7 mm

Reference Key

Master of 2 cm x 4 cm x 5 cm box used on pages 33-39



CAPACITY AND MASS WORKSHEET*

8. Take a field trip to the supermarket.

a. Review the symbols of metric units.

Fill in the name of the metric unit.	Cross out all incorrect symbols. (HINT: There is only one correct symbol in each row.)					
	KG	kG	kg.	kg	Kg.	Kg
	mm	MM	Mm.	mM	mm.	Mm
	CM.	Cm	cM	cm	cm.	CM
	grs.	g	gm	grm	gr	gms.
	M	M.	m	met.	metr.	mt
	Li	L.	l	l.	li.	l.
	ML	mLi	ml	mli.	mL.	Ml
	MGS	mgs	mgm	MG	mgr.	mg
	km	KM.	km.	kM	Km	KM

b. Find items in the store which use incorrect metric symbols on the label.

ITEM	INCORRECT METRIC SYMBOL
_____	_____
_____	_____
_____	_____
_____	_____

c. List items that have metric weights on their labels.

ITEM	WEIGHT
_____	_____
_____	_____
_____	_____
_____	_____

d. List items that have metric capacity units on their labels.

ITEM	METRIC CAPACITY UNIT
_____	_____
_____	_____
_____	_____
_____	_____

e. List items that are sold by customary units only.

_____ _____

_____ _____

*See Activity #4, page T-16

SUPPLIES AND EQUIPMENT NEEDED

Material	Material Obtained from*	Amount Needed for 30 Students	Approximate Cost per Item
Adding machine tape		1 roll	
Ballpoint pen		30	
Bottle (e.g. pill bottle)		5	
Box A (4 cm x 5 cm x 2 cm		30	
Cardboard strips (~12" x 1")		60	
Celsius thermometer	EN	15	5.95 (5/set)
Centimeter cubes	CP	1000	19.00 (1000/set)
Centimeter height measure tape	CP	1	2.50
Chalkboard eraser		3	
Coffee cup		3	
Coke can		3	
Construction Paper (12" x 18")		30	
Dime		6	
Dish		5	
Glue		6 bottles	
Graduated cylinder marked in milliliters	OH	2	3.45
Gram scale	CP	2	21.25
Ice cubes		40	
Index cards (5" x 8")		60	
Juice can		3	
Kilogram scale	OH	1	14.95
Liter pitcher	EN	2	4.95
Masking tape		1 roll	
Matchbox		2	
Mayonnaise jar		3	
Meter stick	CP	12	3.00
Milk carton		3	
Nails (labeled nail A, nail B, nail C, nail D, nail E)		30 (6 ea.)	
Nickel		6	
Oak tag (28 cm x 5 cm)		30	
Paperclip box (empty)		2	
Penny		6	
Quarter		6	
Ruler, inch		15	
Scissors		15	
Shoebox		2	
Soda cup		3	
Staples box (empty)		2	
String (60 cm long)		30	
Textbook		15	
Wastepaper basket (small)		2	
Water		~3 liters	
Yardsticks		6	

* The materials purchased for the try-out of this module were from these companies:
EN - Enrich c/o H. P. Ross, 1308 Hart Street, Honolulu, HI 96817
OH - Ohaus c/o H. P. Ross, 1808 Hart Street, Honolulu, HI 96817
CP - Creative Publications, P. O. Box 10328, Palo Alto, CA 94303

Many other vendors may stock the above listed materials including the following:
Activity Resources Company, Inc., P. O. Box 4875, Hayward, CA 94540
Dick Blick, Box 1267, Calesburg, IL 61401
Creative Teaching Associates, P. O. Box 7766, Fresno, CA 93727
Cuisenaire Co. of America, Inc., 12 Church St., New Rochelle, N.Y. 10805
Ideal c/o H. P. Ross, 1308 Hart Street, Honolulu, HI 96817

QUIZ 1

1. The main metric unit of length is _____.

2. Other common metric units of length studied in this class are:

   _____

   _____

   _____

3. Name an object or a distance that is about:

   a. 1 meter long _____

   b. 1 centimeter long _____

   c. 1 millimeter long _____

   d. 8 kilometers long _____

4. Write the metric prefix which means:

   a. one thousand _____

   b. one hundred _____

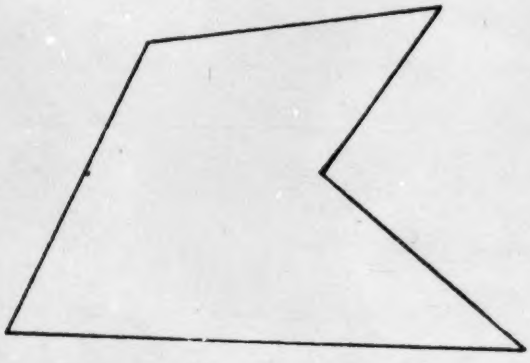
   c. ten _____

   d. one-tenth _____

   e. one-hundredth _____

   f. one-thousandth _____

5. Find the perimeter to the nearest millimeter.



P = _____

6. Circle the measurement that is closest to the actual length.

a.	Football	30 *cm*	3 *m*	60 *cm*
b.	Distance around a high school track	50 *m*	400 *m*	1000 *m*

7. Fill in the blanks.

a. 40 *mm* = _____ *cm*

b. 5.8 *cm* = _____ *mm*

c. 523 *cm* = _____ *m*

d. _____ = _____
(You make up one)

8. 37.6 *cm* + 28.43 *cm* = _____ *cm* = _____ *mm*

QUIZ 2

1. Write cm^2, m^2, or km^2 as the most appropriate unit to use to measure the area of each surface.

   a. A postage stamp _____

   b. A bedroom floor _____

   c. The island of Kahoolawe _____

   d. The amount of leather needed to make a volleyball _____

2. For each object named below, write cm^3 or m^3 as the appropriate unit for finding the volume.

   a. A classroom _____

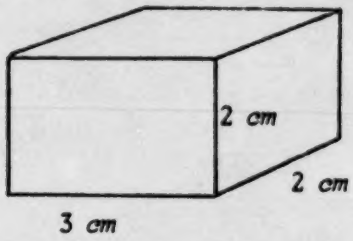
   b. An ice cream carton _____

   c. A matchbox _____

3. Find the area.

_____

4. Find the volume.



_____

5. The main metric unit of capacity is _____.

6. Write l, ml, or kl as the most appropriate unit to measure the following:

   a. Jelly jar _____ b. Washtub _____

   c. Orange soda can _____ d. Fish pond _____

7. The main metric unit of mass is _____.

8. Write g, mg, or kg as the most appropriate unit to measure the following:

   a. Yourself _____ b. Your wallet _____

   c. An aspirin tablet _____ d. Pencil _____

9. Write the numerical value of the six common metric prefixes:

   a. kilo- _____ b. hecto- _____

   c. deka- _____ d. deci- _____

   e. centi- _____ f. milli- _____

10. Circle the most appropriate measurement of capacity or mass for each object.

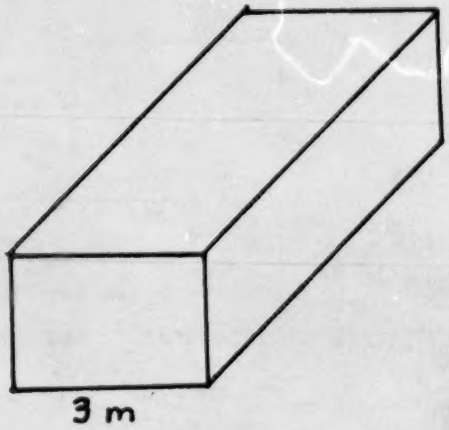
a. chalkboard eraser	50 *mg*	50 *g*	50 *kg*
b. can of rootbeer	15 *ml*	350 *ml*	3 *l*

11. Complete each statement by filling in the appropriate unit: *kg*, *g*, *mg*, *kl*, *l*, or *ml*.

a. Bill used 200 _____ of milk to make a milkshake.

b. A woman's ring weighs 4 _____.

12. Label the length and height of this box with possible measurements so it has a volume of 30 m^3. The width has been labeled 3 *m*.



QUIZ 3

1. The metric unit to measure temperature for practical situations is

   _____ .

2. Write metric temperatures for the following:

   a. Freezing point of water _____

   b. Boiling point of water _____

   c. Usual Hawaiian temperature _____

   d. Normal body temperature _____

3. Select the temperature that is the best approximation for the following situations:

a. Hot day in Hawaii	22° *C*	33° *C*	55° *C*
b. Ice cream out of the freezer	-5° *C*	40° *C*	60° *C*
c. Spaghetti sauce just right for eating	10° *C*	30° *C*	70° *C*
d. Fever because of a cold	20° *C*	38° *C*	101° *C*

4. Write the six metric prefixes from largest to smallest.

			meter liter gram			

5. Use the chart in problem 4 to convert the given metric measurement to the specified metric unit.

   a. 42 *g* = _____ *cg*

   b. 2.3 *km* = _____ *m*

   c. 450 *ml* = _____ *l*

   d. 17.5 *dg* = _____ *dag*

   e. 68.4 *cm* = _____ *mm*

   f. 258.1 *dl* = _____ *hl*

MEASURING IN METRIC Name 1 _____

TEST Date _____

Circle the best approximation.

1. The height of a door is: 1 *m* 2 *m* 3 *m*
2. A water glass holds: 2 *l* 20 *ml* 200 *ml*
3. An adult man weighs: 75 *kg* 200 *g* 150 *kg*
4. The temperature on a nice day in Hawaii is: 25° *C* 55° *C* 80° *C*

Circle the most appropriate unit for measuring.

5. Length of a pencil *mm* *cm* *m* *km*
6. Capacity of a coke can *ml* *l* *kl*
7. Weight of a bag of rice *mg* *g* *kg*
8. Area of the kitchen floor cm^2 m^2 km^2
9. Volume of an ice cream carton cm^3 m^3

Give your body measurements in metric units.

10. Your height _____
11. Your weight _____

Give metric temperatures for the following.

12. Freezing point of water _____
13. Boiling point of water _____
14. Normal body temperature _____

Name the main metric unit for:

15. Length _____
16. Capacity _____
17. Mass _____
18. Temperature _____
19. Area _____
20. Volume _____

Write the six metric prefixes and their corresponding numerical value.

	PREFIX	NUMERICAL VALUE
21.		
22.		
23.		
24.		
25.		
26.		

Write the following measurements using correct symbols.

27. Three meters _____
28. Twenty-four dekagrams _____
29. Fifteen milliliters _____
30. Twelve square centimeters _____

Circle the best approximation.

31. 1 meter is about 1 in. 1 ft. 1 yd.
32. 1 liter is about 1 pt. 1 qt. 1 gal.
33. 2 centimeters is about 1 in. 1 ft. 1 yd.
34. 1 kilogram is about 2 oz. 2 lb. 2 T.
35. 1 kilometer is about 0.6 yd. 0.6 rd. 0.6 mi.

Covert the given metric measurement to the specified unit.

36. 2 *m* = _____ *cm*

37. 35 *ml* = _____ *l*

Find the sum.

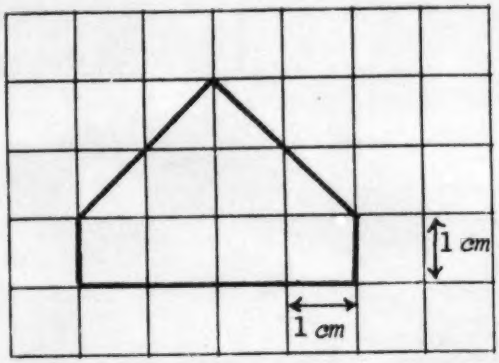
38. 45.976 + 8.23 = _____

Find the difference.

39. 28.05 - 1.708 = _____

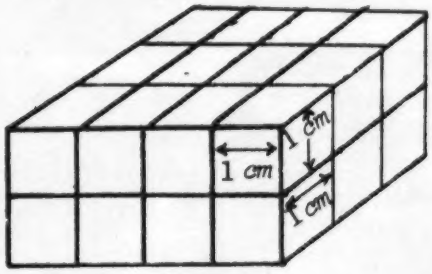
Find the area. _____

40.



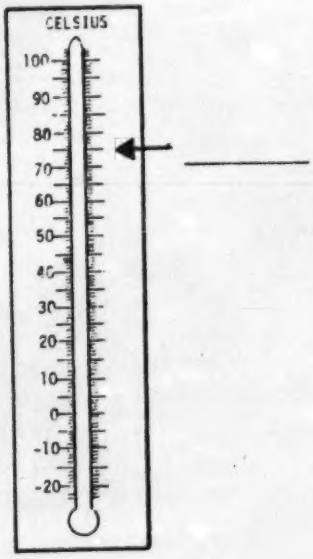
Find the volume. _____

41.



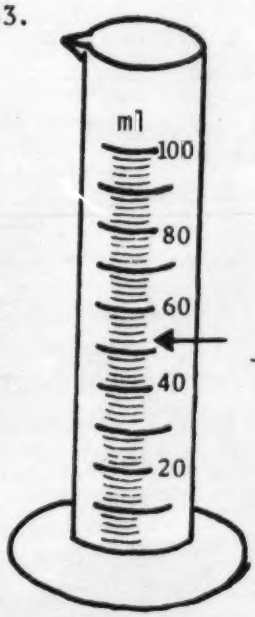
Read the following measurements.

42.



_____

43.

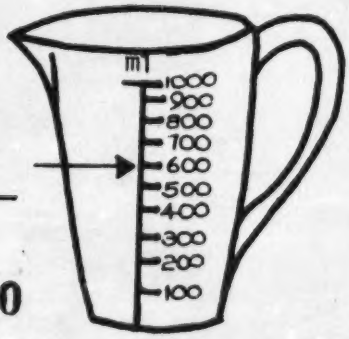


_____

44.

_____

45.



_____

40

Name _____

Date _____

Measure the items marked A, B, C, D, and E. Write the name of the item to be measured and write its measurement in the chart below.

		NAME	MEASUREMENT
46.	ITEM A		
47.	ITEM B		
48.	ITEM C		
49.	ITEM D		
50.	ITEM E		

ANSWER KEY

Metric Rulers, pages 3-5

1. 40 *mm* 2. 50 *mm* 3. 25 *mm* 4. 32 *mm* 5. 10 *mm*
6. 270 *mm* 7. 156 *mm* 8. 109 *mm* 9. 231 *mm* 10. 7 *mm*
11. 1 *dm* 12. 20 *cm* 13. 100 *cm* 14. 10 *dm* 15. 100 *cm*
16. One meter is longer than one yard. 17. One meter is about 1 *dm* OR 8 *cm* OR 3 inches longer than one yard.
18. One inch is longer than one centimeter.
19. One inch is about 2.5 centimeters. 20. 5 *cm* is about 2 inches.
21. 10 *cm* 22. 100 *mm* 23. 10 *mm* 24. 100 *cm* 25. 1000 *mm*

ANSWERS WILL VARY FOR THE OBJECTS NAMED IN THE THREE EXERCISES THAT FOLLOW.

Length (The Meter), pages 6-8

1. Answers may vary. These are the most probable answers:
   a. longer than one meter b. about one meter c. shorter than one meter
   d. shorter than one meter e. shorter than one meter f. about one meter
   g. longer than one meter h. about one meter
2. Answers will vary. 4. Answers will vary. 5. Answers will vary.
6. Answers will vary. 7. Answers will vary.
8. a. 5 *m* b. 1 *m* c. 2 *m* d. 17 *m* e. 4 *m* f. 5 *m*
   g. 8 *m* h. 30 *m* i. 50 *m*
9. Some suggested answers are:
   a. Height of washer or dryer, width of bed or crib, length of desk, etc.
   b. Length of teacher's desk, height of chalkboard, width of door, width of window, etc.
   c. toe to waist, face to tip of fingers, etc.
   d. golf club, baseball bat, width of volleyball net, etc.
   e. width of shower stall, eave of a house, width of hallway, etc.
   f. height of motorcycle, width of telephone booth, etc.
10. ***** For a classroom 8 m x 9 m x 3 m, shortest web is approximately 13 m* ($\sqrt{64 + 81 + 9}$).

Length (The Centimeter), pages 9-11

1. Answers will vary for the estimations and differences. The measurements are as follows: a. 4 *cm* b. 3 *cm* c. 5 *cm* d. 5 *cm* e. 6 *cm*
2. 23 *cm*; 3 *cm*
3. Drawings using centimeter ruler: a. b. c. d.

Length (The Centimeter), pages 9-10 continued

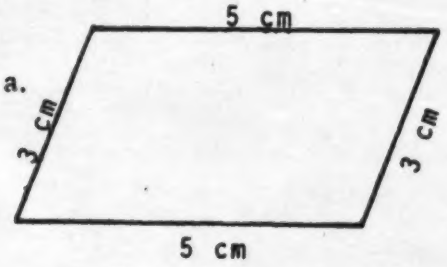
4. a. 5 *cm* b. 6 *cm* c. 11 *cm* 5. Answers will vary.

6. Answers will vary. 7. **** *If the width of the room is 8 m, the 2-cm worm reaches the other end at 9:40.*
(2 x 10 = 20 cm/min.; 800 cm ÷ 20 cm/min. = 40 min.)

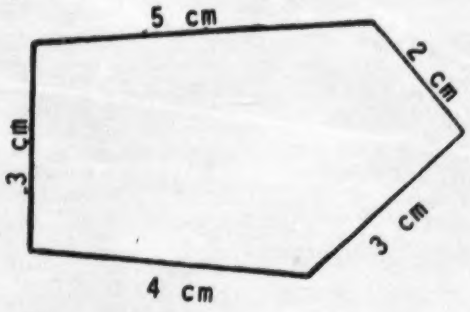
Perimeter, pages 12-14

1. 9 *cm* b. 12 *cm* c. Answers will vary.

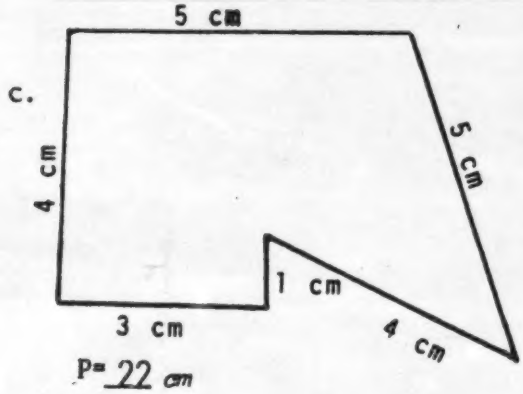
2.



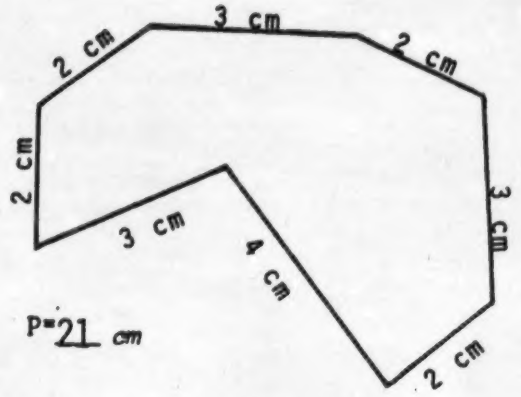
P= 16 *cm*



P= 17 *cm*



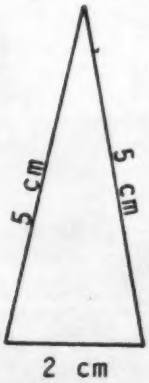
P= 22 *cm*

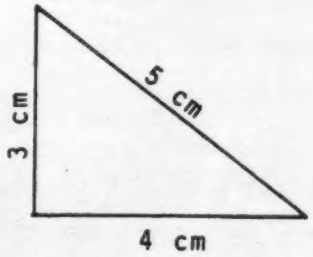


P= 21 *cm*

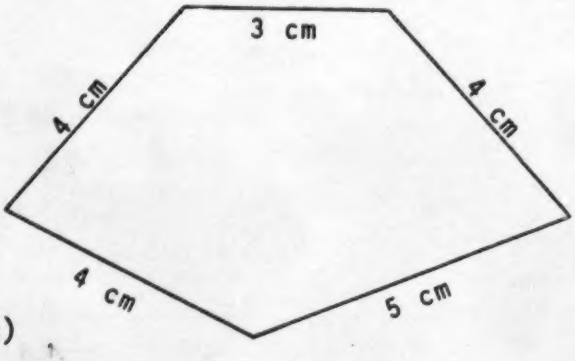
3.

a. 3 sides; perimeter 12 *cm*





b. 5 sides; perimeter 20 *cm*



(SOME POSSIBLE ANSWERS)

Perimeter, pages 12-14 continued

4. Answers will vary. 5. Baseball diamond: P = 120 *m*

Football field: P = 320 *m* Olympic-size swimming pool: P = 150 *m*

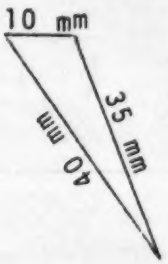
6. **** *Deci 54.3 cm ; Centi 51.8 cm ; Milli 52.9 cm ; Kilo 56.1 cm ; Hecto 54.0 cm ; Deka 52.6 cm*

Length (The Millimeter), pages 15-17

1. Answers will vary. 2.

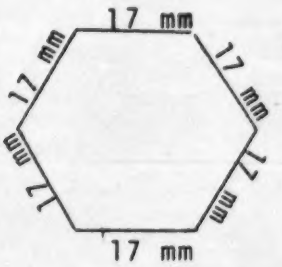
COIN	DIAMETER MEASUREMENT	THICKNESS
Penny	*19 mm*	*1 mm*
Nickel	*21 mm*	*2 mm*
Dime	*18 mm*	*1 mm*
Quarter	*24 mm*	*2 mm*

3. a.



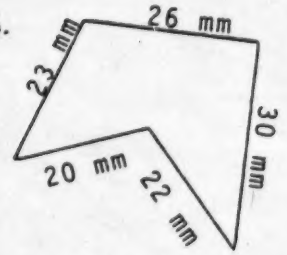
P = 85 mm

c.



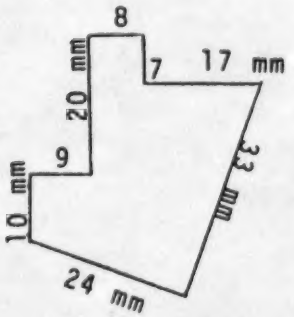
P = 102 mm

b.



P = 121 mm

d.



P = 128 mm

4. Answers will vary. 5. a. 14.8 b. 18.847 c. 9.44
d. 1.47 e. 852.29 f. 90.002

6. *** *Dale is about 14 mm , and Gale is about 13 mm .*

**** *It would take the snail 24 days to get out. (230 ÷ (30 - 20) = 23 days to go the distance 230 mm , and the next day to get out.)*

Length (The Kilometer), pages 18-21

1.

MILES	KILOMETERS
10	10 + 5 + 1 = 16
20	20 + 10 + 2 = 32
30	30 + 15 + 3 = 48
40	40 + 20 + 4 = 64
50	50 + 25 + 5 = 80
60	60 + 30 + 6 = 96
70	70 + 35 + 7 = 112
80	80 + 40 + 8 = 128
90	90 + 45 + 9 = 144
100	100 + 50 + 10 = 160
110	110 + 55 + 11 = 176
120	120 + 60 + 12 = 192

2. b. 8 *km* c. 26 *km* d. 80 *km*
e. 83 *km* f. 40 *km*

128 *km* 122 *km* 96 *km*
94 *km* 86 *km*

3. DISTANCES BETWEEN THE HAWAIIAN ISLANDS

	HAWAII	KAUAI	LANAI	MAUI	MOLOKAI	OAHU
KAUAI	260 mi. 416 km	X	170 mi. 272 km	190 mi. 304 km	150 mi. 240 km	80 mi. 128 km
LANAI	70 mi. 112 km	170 mi. 272 km	X	10 mi. 16 km	10 mi. 16 km	50 mi. 80 km
MAUI	30 mi. 48 km	190 mi. 304 km	10 mi. 16 km	X	10 mi. 16 km	70 mi. 112 km
MOLOKAI	90 mi. 144 km	150 mi. 240 km	10 mi. 16 km	10 mi. 16 km	X	30 mi. 48 km
OAHU	140 mi. 224 km	80 mi. 128 km	50 mi. 80 km	70 mi. 112 km	30 mi. 48 km	X
NIIHAU	300 mi. 480 km	20 mi. 32 km	210 mi. 336 km	230 mi. 368 km	190 mi. 304 km	120 mi. 192 km

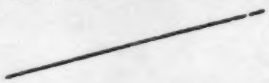
Length (The Kilometer), pages 18-21 continued

4. Some examples are: a. Makaha to Makua; Waianae to Nanakuli; Kahuku to Hauula
   b. Aiea to Waipahu; Hauula to Kahana
5. Answers will vary.
6. ***** If they travelled at a constant speed of 80 km/hr., they reached Makaha at 10:12 . (32 ÷ 80 = 1/5; 1/5 x 60 min. = 12 min.)*

Length, pages 22-25

1 *km* = 1 000 *m* ; 1 *hm* = 100 *m* ; 1 *dam* = 10 *m* ; 1 *dm* = 0.1 *m* ;
1 *cm* = 0.01 *m* ; 1 *mm* = 0.001 *m*

1. one-tenth, 0.1 *m* ; one hundred times, 100 *m* ; one-thousandth, 0.01 *m* ; one thousand times, 1 000 *m* ; one-hundredth, 0.001 *m* ; ten times, 10 *m*
2. one-hundredth, \$0.01 or 1¢; one-tenth, \$0.10 or 10¢; one thousand times, \$1000.00; one-thousandth, \$0.001 or 0.1¢ or 1 mill
3. one-thousandth, 1 000 millimeters; one-hundredth, 100 *cm* ; one-tenth, 10 *dm*
4. a. centi b. hecto c. milli d. kilo
5.

LINE SEGMENT	ESTIMATE	MEASUREMENT
	_____ *cm* _____ *mm*	4 *cm* 39 *mm*
	_____ *cm* _____ *mm*	1 *cm* 14 *mm*
	_____ *cm* _____ *mm*	8 *cm* 75 *mm*

6. a. 160 *cm* b. 18 *m* c. 192 *mm* d. 10 000 *m* e. 8 *m*
7. a. *m* b. *mm* or *cm* c. *km* d. *m* e. *km*
8. a. *m* b. *cm* c. *m* d. *km* e. *cm*
9. a. Length of a bed b. Diameter of a dinner plate; Length of a football
   c. Diameter of a penny; Width of a dollar bill d. Length of a whale (possible answer for some whales); Height of a mango tree
10. a. meter b. *cm* c. millimeter d. kilometer
11. Answers will vary.
12. a. 11.70 b. 43.32 c. 14.574 d. 8.97 e. 64.375
    f. 19.74 g. 0.225 h. 6.633 i. 0.551 2- j. 1.26

Area, pages 26-32

Answers will vary for the activity involving making a square decimeter.

Area, pages 26-32 continued

1. a. 4.5 cm^2 b. 18 cm^2 c. 4 cm^2 d. 7 cm^2 e. 12.5 cm^2
f. 5.5 cm^2 2. Answers will vary.
3. b. 7.5 cm^2 c. 19 cm^2 d. 9 cm^2 e. 12 cm^2 f. 14 cm^2
4. a. cm^2 b. km^2 c. m^2 d. m^2 e. cm^2 f. m^2 g. cm^2
h. cm^2 5. a. about 39 cm^2 b. 42 cm^2 c. 38 cm^2
6. Answers will vary. NOTE: Have the students outline their hands with their fingers together to make counting the surface area easier.
7. a. A = 3 cm^2 ; P = 9 cm b. A = 8 cm^2 ; P = 16 cm c. A = 16 cm^2 ; P = 16 cm
8. a. 25 cm^2 b. Answers will vary
c. 6.25 cm^2 d. $\frac{1}{4}$
9. **** *2,088 pieces of tile (920 ÷ 23 = 40, 1,200 ÷ 23 = 52 r 4 cm A tile can be cut to give 5 strips of 4 cm width. 8 tiles cut into 4-cm strips gives 40 strips. Therefore, 40 x 52 + 8 = 2,088)*

Volume, pages 33-39

3. a. cm^3 b. m^3 c. m^3 d. cm^3 e. cm^3 f. cm^3
4. a. 27 cubes b. 18 cubes c. 24 cubes d. 32 qubes
5. a. 4 cubic centimeters b. 5 rows; 20 cubic centimeters c. 2 layers
d. 40 cubic centimeters; 4 x 5 x 2 = 40
6. a. 24 cm^3 b. 60 cm^3 c. 24 cm^3 d. 160 cm^3 e. 56 cm^3
f. 60 cm^3 g. 384 cm^3 h. 420 cm^3 i. 648 cm^3 j. 1600 cm^3
7. Answers will vary. 8. a. 45 m^3 b. 60 m^3 c. 48 m^3 d. 80 m^3
e. 112 m^3 f. 144 m^3 9. a. 1 000 cubic centimeters
b. 1 000 cubic decimeters **c. 1 000 000 cubic centimeters
10. **** *20 people (1 300 000 - 60 000 = 21; 21 - 1 = 20 , -1 for space taken by the telephone)*

Capacity, pages 40-43

1. a. 0.001, 0.001 b. less than, very small c. 1000, 1 000
d. more than, very large 2. a. ml b. ml or l c. ml
d. kl e. kl f. kl g. ml h. ml i. ml j. l
3. Answers will vary. 4. a. 95 ml b. 80 ml c. 63 ml
d. 40 ml e. 29 ml f. 12 ml g. 800 ml h. 460 ml i. 240 ml
j. 80 ml 5. a. 500 ml b. 8 l c. 50 l d. 200 ml
e. 4 l f. 240 ml g. 400 l h. 4 l i. 1 ml j. 300 ml
6. a. kilo- b. hecto- c. deka- d. deci- e. centi- f. milli-
7. 1 000 l = 1 kl ; 100 l = 1 hl ; 10 l = 1 dal ; 0.1 l = 1 dl ;
0.01 l = 1 cl ; 0.001 l = 1 ml 8. a. 3 000 l b. 400 l
c. 50 l d. 2 l e. 0.3 l f. 0.5 l

Capacity, pages 40-43

9. **** *Here are some possible solutions:*

(1) $5\ l + 5\ l = 10\ l$
$10\ l - 3\ l - 3\ l = 4$ *liters*

(2) $5\ l + 3\ l + 3\ l = 11\ l$
$11\ l - 5\ l - 5\ l = 1\ l$
$3\ l + 1\ l = 4$ *liters*

Mass, pages 44-45

1. b. 500 *g* c. 1 000 *g* d. 0.175 *kg* e. 20 000 *g* f. 0.450 *kg*

2. Answers will vary. 3. a. *kg* b. *g* c. *kg* d. *kg*

e. *mg* f. *g* 4. a. *g* b. *kg* c. *kg* d. *g*

5. Answers will vary. 6. a. 36.1 b. 16.13 c. 7.519

d. 136.97 e. 31.685 f. 70.523 7. a. 12.1 b. 7.62

c. 3.9 d. 21.37 e. 3.022 f. 11.194

8. **** *In three measurements:* *(1)* 4 4 *If they balance, the odd one is light. If not, remeasure lighter side and the light ball is found.*

(2) 2 2

(3) 1 1

**** *In two measurements:* *(1)* 3 3 *If balanced, take the remaining 3 and the light ball is found. If not, take the lighter of the two groups measured and the light ball is found.*

(2) 1 1

Capacity and Mass, pages 46-49

1.

NAME	SYMBOL
LITER	l
MILLILITER	ml
KILOLITER	kl
HECTOLITER	hl
DEKALITER	dal
DECILITER	dl
CENTILITER	cl

2. a. 2 *l* b. 1 500 *ml* c. 12 *l* d. 3 *l*

3.

NAME	SYMBOL
GRAM	g
KILOGRAM	kg
MILLIGRAM	mg
CENTIGRAM	cg
DECIGRAM	dg
DEKAGRAM	dag
HECTOGRAM	hg

4. a. 2 *kg* b. 5 *kg* c. 3 000 *g* d. 1 *kg*

Capacity and Mass, pages 46-49

5. a. pencil b. 1/2-gallon milk carton c. 2 paper clips
d. bowling ball e. teaspoon f. adult's weight
6. a. no b. yes c. no d. yes e. no f. yes
7. a. telephone book; newborn baby b. cup of orange soda; bottle of catsup
8. a. 4.41 b. 0.986 c. 15.05 d. 15.5
9. Mars 40 *g* ; Uranus 90 *g* ; Neptune 120 *g*
10.

	EARTH	MOON	JUPITER	MARS	URANUS	NEPTUNE
Astronaut	72 *kg*	12 *kg*	187 *kg*	29 *kg*	65 *kg*	86 *kg*
4 books	600 *g*	100 *g*	1560 *g*	240 *g*	540 *g*	720 *g*
Jeep	1 400 *kg*	234 *kg*	3 640 *kg*	560 *kg*	1260 *kg*	1680 *kg*
TV set	40 *kg*	7 *kg*	104 *kg*	16 *kg*	36 *kg*	48 *kg*
Refrigerator	220 *kg*	37 *kg*	572 *kg*	88 *kg*	198 *kg*	264 *kg*
Dog	25 *kg*	4 *kg*	65 *kg*	10 *kg*	23 *kg*	30 *kg*
You		ANSWERS WILL VARY.				

11. **** *Crackers - 1 kg is a lot of crackers.*
Punch syrup - about 2 gallons
Potato chips - 15 kg is unreasonable.
Peaches - 10 g is too light.
Hot dog - 1 gam wouldn't feed a baby.
Cola - 1 liter cans are not made.
Mustard - 1 liter would be restaurant supply.
Butter - too light
7-Up - A large bottle is about 1 liter.

Temperature, pages 50-51

1. a. 38° C b. 50° C c. 15° C d. 60° C e. 1535° C
f. 40° C g. 0° C h. 70° C i. 28° C j. -20° C
2. a. A 70° C ; B 35° C b. A 86° C ; B 0° C c. A 69° C ;
B 24° C d. A 37° C ; B -11° C
3. b. c. d.

Temperature, pages 52-53

1. Answers will vary. 2. b. Snowstorm in the Midwest; Temperature in freezer compartment c. Normal body temperature; Warm bathwater
d. Temperature for baking a cake; Outdoor campfire
3. a. 42.5° C b. 40.9° C c. 39.1° C d. 37.0° C e. 35.3° C
f. 41.6° C g. 40.2° C h. 38.4° C i. 36.8° C j. 35.5° C
4. Answers will vary. 5. **** 730° C (480° + 250°)

Converting Metric Units of Length, pages 54-55

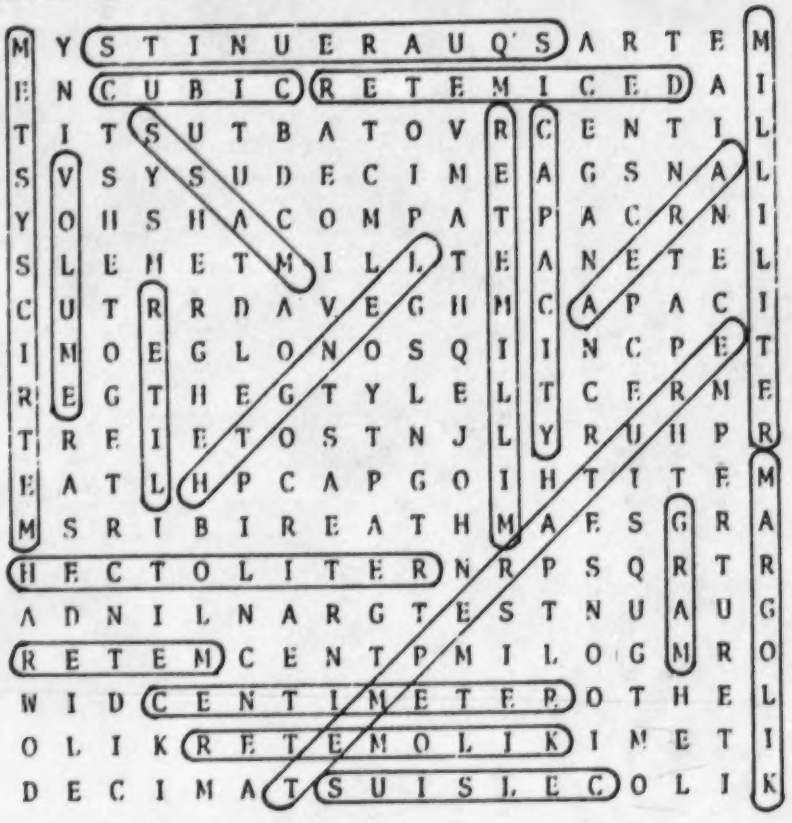
1. 40 *mm* 2. 45 *mm* 3. 1.5 *cm* 4. 230 *mm* 5. 10.5 *cm*
6. 100 *mm* 7. 2 *dm* 8. 2.5 *dm* 9. 10 *cm* ; 1 *cm* is 1/10 of a decimeter.
10. 10 *mm* ; 1 *mm* is 1/10 of a centimeter. 11. 100 *mm* ; 1 *mm* is 1/100 of a decimeter.
12. 0.12 *dm* 13. 0.43 *dm* 14. 4.3 *dm* 15. 8.3 *dm* 16. 0.07 *dm*
17. 13 *cm* 18. 0.008 *m* = 0.08 *dm* = 0.8 *cm* = 8 *mm*
19. 0.15 *m* = 1.5 *dm* = 15 *cm* = 150 *mm*
20. 30 *m* = 300 *dm* = 3 000 *cm* = 30 000 *mm*
21. 1.95 *m* = 19.5 *dm* = 195 *cm* = 1 950 *mm* 22. 15 *cm*
23. 30 000 *mm* 24. 1.95 *m* 25. 300 *cm* 26. 46 *dm* 27. 5.5 *m*
28. 0.225 *m* 29. 0.2 *m* 30. 1.4 *km* 31. 360 *mm* 32. 1.12 *dm*
33. 210 *m* 34. 458.9 *dam* 35. 5.9 *dm* = 590 *mm*
36. 25 *cm* + 3 *cm* + 4 *cm* = 32 *cm* = .32 *m* 37. 6 480 *mm* = 6.48 *m*
38. 4.9 *cm* = 49 *mm* 39. 1 500 *mm* - 966 *mm* = 2 466 *mm* = 2.466 *m*
40. 712 *cm* = 71.2 *dm*

Converting Metric Units, pages 56-57

1. 0.007 *kl* 2. 1.033 *m* 3. 23 *hm* 4. 0.25 *l* 5. 4 750 *dg*
6. 1.5 *km* 7. 2 800 *ml* 8. 28 000 *g* 9. 91.4 *hg* 10. 62 500 *l*
11. 750 *m* 12. 2 100 *cl* 13. 0.22 *kg* 14. 0.62 *hl*
15. a. 47.66 *g* ; 47 660 *mg* b. 430.71 *g* ; 0.430 71 *mg*
c. 20.511 *m* ; 2 051.1 *cm* d. 127.87 *ml* = 0.127 87 *l*
e. 623.95 *cm* = 0.623 95 *dam* 16. b. 3 000 *ml* and 450 *ml* = 3 450 *ml*
c. 1 000 *g* and 2 568 *g* = 3 568 *g* d. 200 *cm* and 30 *cm* and 65 *cm* = 295 *cm*
e. 20 000 *cl* and 1 500 *cl* and 456 *cl* = 21 956 *cl*
17. a. 1.5 *km* b. 300 *hm* c. 890 *cm*
18. a. 2.54 *cm* = 0.025 4 *m* ; 1610 *km* = 1 610 000 *m*
b. 28 *mg* = 0.028 *g* ; 2.2 *kg* = 2 200 *g*

Metric Mania, pages 58-59

1.


M Y S T I N U E R A U Q S A R T E M
E N C U B I C R E T E M I C E D A I
T I T S U T B A T O V R C E N T I L
S V S Y S U D E C I M E A G S N A L
Y O H S H A C O M P A T P A C R N I
S L E M E T M I L L T E A N E T E L
C U T R R D A V E G H M C A P A C I
I M O E G L O N O S Q I I N C P E T
R E G T H E G T Y L E L T C E R M E
T R E I E T O S T N J L Y R U H P R
E A T L H P C A P G O I H T I T E M
M S R I B I R E A T H M A E S G R A
H E C T O L I T E R N R P S Q R T R
A D N I L N A R G T E S T N U A U G
R E T E M C E N T P M I L O G M R O
W I D C E N T I M E T E R O T H E L
O L I K R E T E M O L I K I M E T I
D E C I M A T S U I S L E C O L I K

2. a. military b. centipede c. Mililani or Makakilo d. Desi Arnez e. Kilauea f. kilowatt 3. a. gram b. decimeter c. volume d. kilometer e. metric system f. dekameter g. kilogram h. liter i. hectometer j. length k. millimeter l. meter m. weight n. milligram 4. a. 0.7 *m* b. 1.4 *m* c. 2.1 *m* d. 2.8 *m* e. 3.5 *m* f. 4.2 *m* g. 4.9 *m* h. 5.6 *m* i. 6.3 *m*

5.6	0.7	4.2
2.1	3.5	4.9
2.8	6.3	1.4

Do You Know?, pages 60-61

1.

kilo-	1 000
hecto-	100
deka-	10
deci-	0.1
centi-	0.01
milli-	0.001

2.

meter	*m*
centimeter	*cm*
millimeter	*mm*
kilometer	*km*

3. cm^2
4. cm^3
5. Answers will vary.
6. Answers will vary.
7. 37° C

Do You Know?, pages 60-61 continued

8. liter *l*
   milliliter *ml*
   kiloliter *kl*

9. gram *g*
   kilogram *kg*
   milligram *mg*

10. meter: about one yard; centimeter: about 2 makes one inch; kilometer: about 2 makes one mile; liter: about one quart; kilogram: about 2 pounds

11. 4 550

12. 1 meter: baseball bat, golf club, width of door, floor to waist, etc.

    1 centimeter: width of paper clip, diameter of chalk, width of fingernail, etc.

    1 kilometer: Ilikai to Ward Warehouse, etc.

    1 liter: quart of milk, small saucepan, large juice can, etc.

    1 kilogram: history textbook, sirloin steak, etc.

    25° C : classroom temperature, nice day, ocean water temperature at Ala Moana, etc.

QUIZ 1

1. meter 2. Any three of the following units of length are acceptable: meter, certimeter, millimeter, kilometer

3. a-d. Answers will vary.

4. a. kilo- b. hecto- c. deka- d. deci- e. centi- f. milli-

5. P = about 24 *mm* 6. a. 30 *cm* b. 400 *m*

7. a. 4 *cm* b. 58 *mm* c. 5.230 *m* d. Answers will vary

8. 66.03 *cm* = 660.3 *mm*

QUIZ 2

1. a. cm^2 b. m^2 c. km^2 d. cm^2 2. a. m^3 b. cm^3
c. cm^3 3. 5.5 cm^2 4. 12 cm^3 5. liter 6. a. *ml*
b. *l* c. *ml* d. *kl* 7. gram 8. a. *kg* b. *g*
c. *mg* d. *mg* 9. a. one thousand b. one hundred c. ten
d. one-tenth e. one-hundredth f. one-thousandth

10. a. 50 *g* b. 350 *ml* 11. a. *ml* b. *g*

12. Either 3 *m* x 2 *m* x 5 *m* OR 3 *m* x 1 *m* x 10 *m*

QUIZ 3

1. degree Celsius 2. a. 0° C b. 100° C c. 20° - 30° C d. 37° C
3. a. 33° C b. -5° C c. 30° C d. 38° C
4. kilo- hecto- deka- deci- centi- milli-
5. a. 420 *cg* b. 2 300 *m* c. 0.45 *l* d. 0.175 *dag* e. 6 840 *mm*
f. 0.258 1 *hl*

TEST

1. 2 *m* 2. 200 *ml* 3. 75 *kg* 4. 25° C 5. *cm* 6. *ml*
7. *kg* 8. m^2 9. cm^3 10. Answer will vary. 11. Answer will vary.
12. 0° C 13. 100° C 14. 37° C 15. meter 16. liter
17. gram 18. degree Celsius 19. cm^2 20. cm^3
21. kilo- ; 1 000 22. hecto- ; 100 23. deka- ; 10
24. deci- ; 0.1 25. centi- ; 0.01 26. milli- ; 0.001
27. 3 *m* 28. 24 *dag* 29. 15 *ml* 30. 12 cm^2 31. 1 yd.
32. 1 qt. 33. 1 in. 34. 2 lb. 35. 0.6 mi. 36. 200 *cm*
37. 0.035 *l* 38. 54.206 39. 26.342 40. 8 cm^2 41. 24 cm^3
42. 75° C 43. 52 *ml* 44. 37° C 45. 600 *ml*
46-50. Answers will vary.